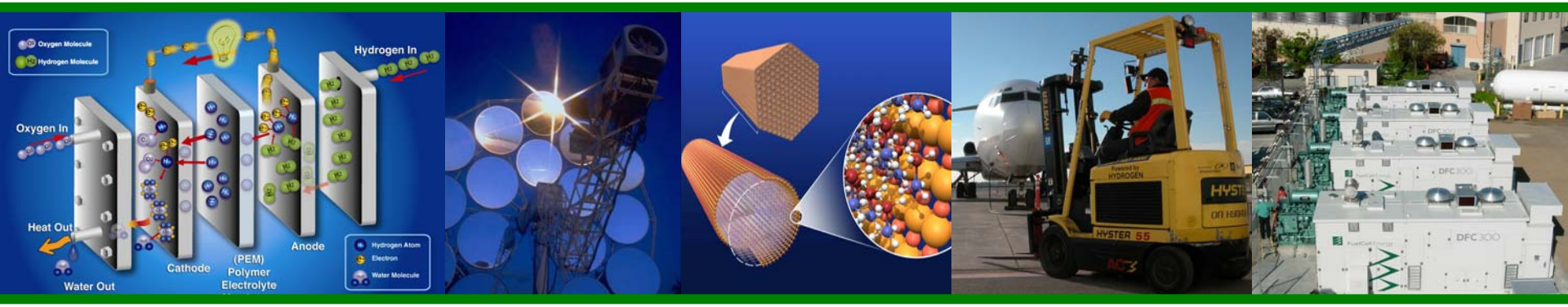


DOE Fuel Cell Technologies Program Update

Sunita Satyapal

Acting Program Manager

Briefing for HTAC

July 15, 2009

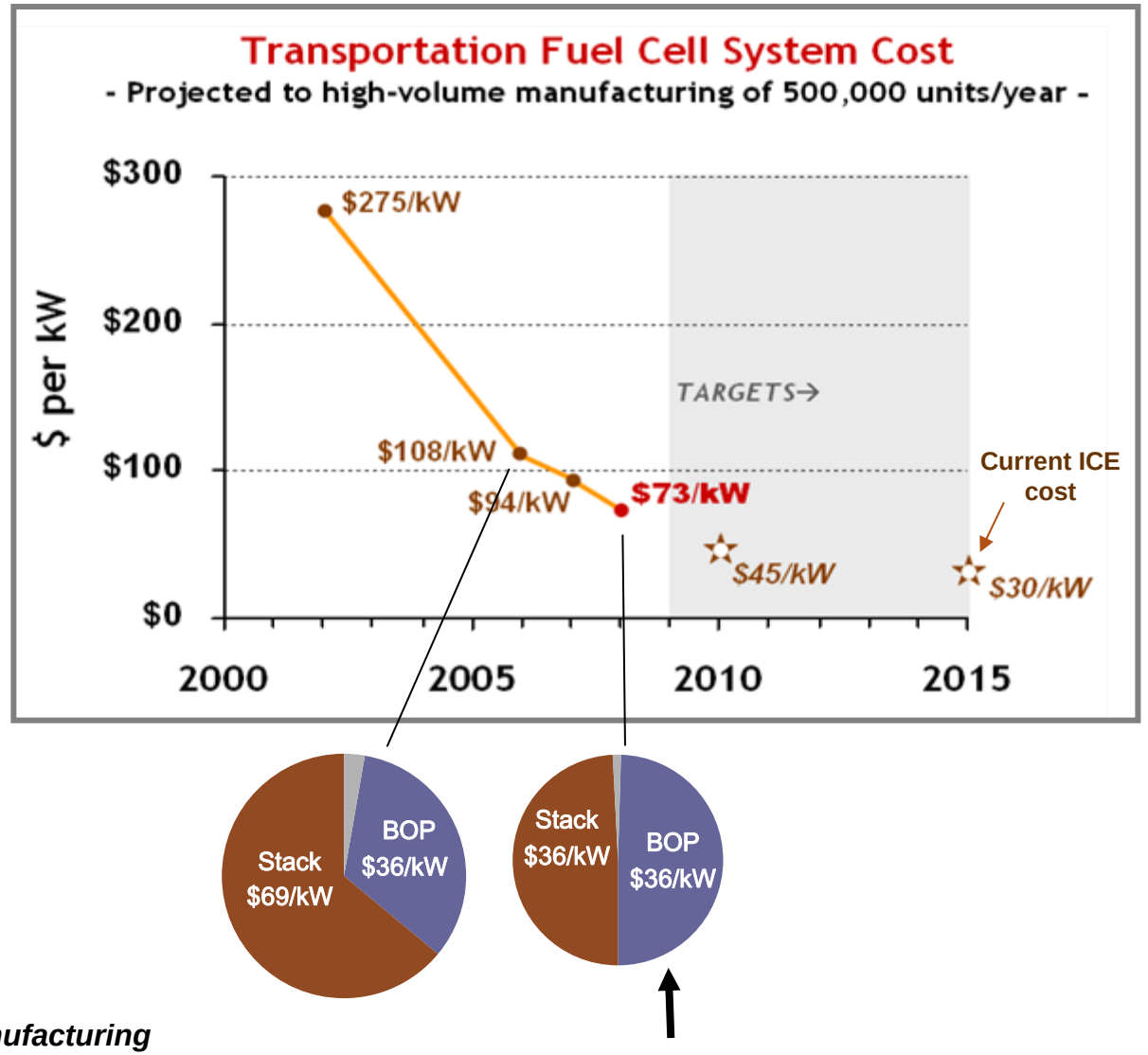
Outline

1. Progress and Accomplishments
2. Recovery Act Update
3. New Program Direction
4. Budgets
5. Legislative Update
6. Program Next Steps
7. Examples of Activities in Other Agencies

Fuel Cell R&D — *Progress*

We've reduced the cost of fuel cells to $73/kW*

- ***Cost projection validated by independent panel*****
- ***More than 20% reduction in one year***
- ***Nearly 75% reduction since 2002***



As stack costs are reduced, balance-of-plant components are responsible for a larger % of costs.

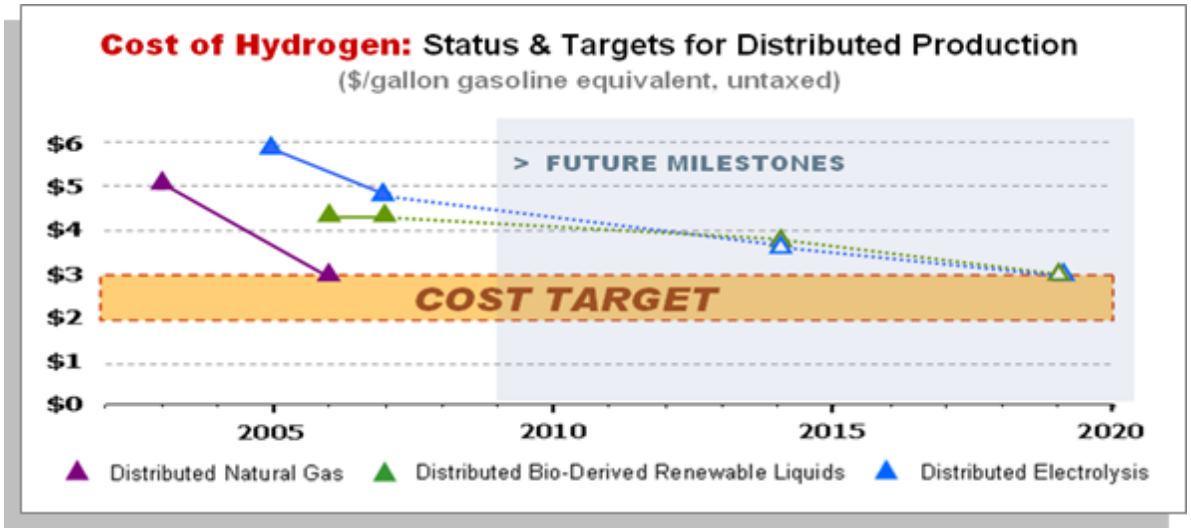
****Based on projection to high-volume manufacturing (500,000 units/year).***

*****Panel found $60 – $80/kW to be a "valid estimate": http://hydrogendoedev.nrel.gov/peer_reviews.html***

H_2 Production and Delivery R&D — *Progress & Accomplishments*

We've reduced the cost* of hydrogen from multiple sources.

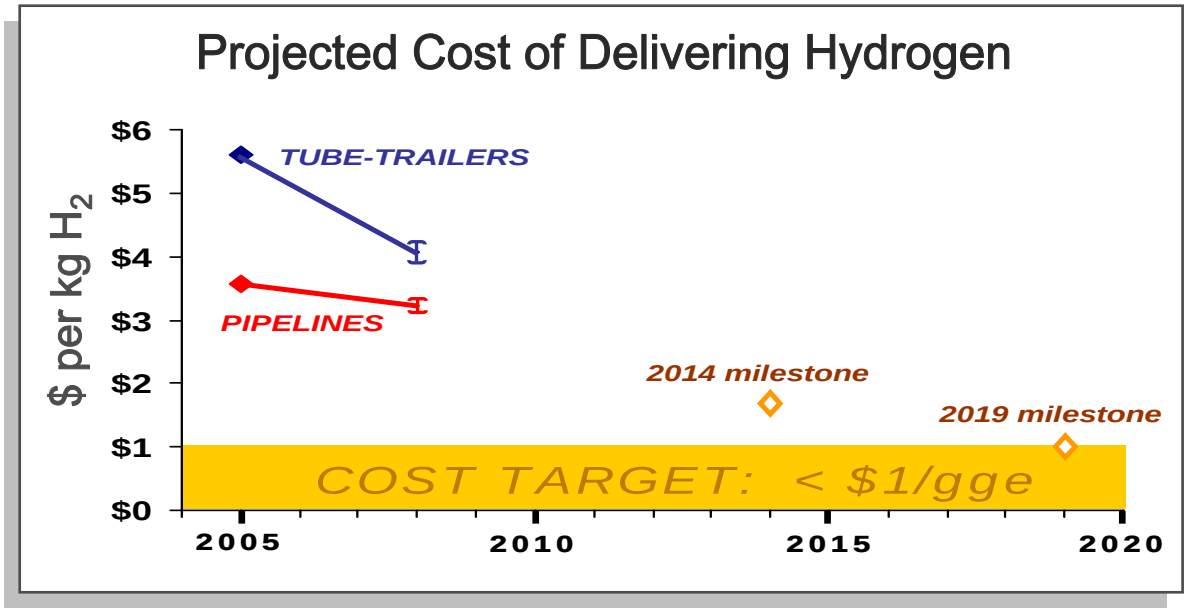
**projected cost, assuming 1500 kg/day, 500 units/year*



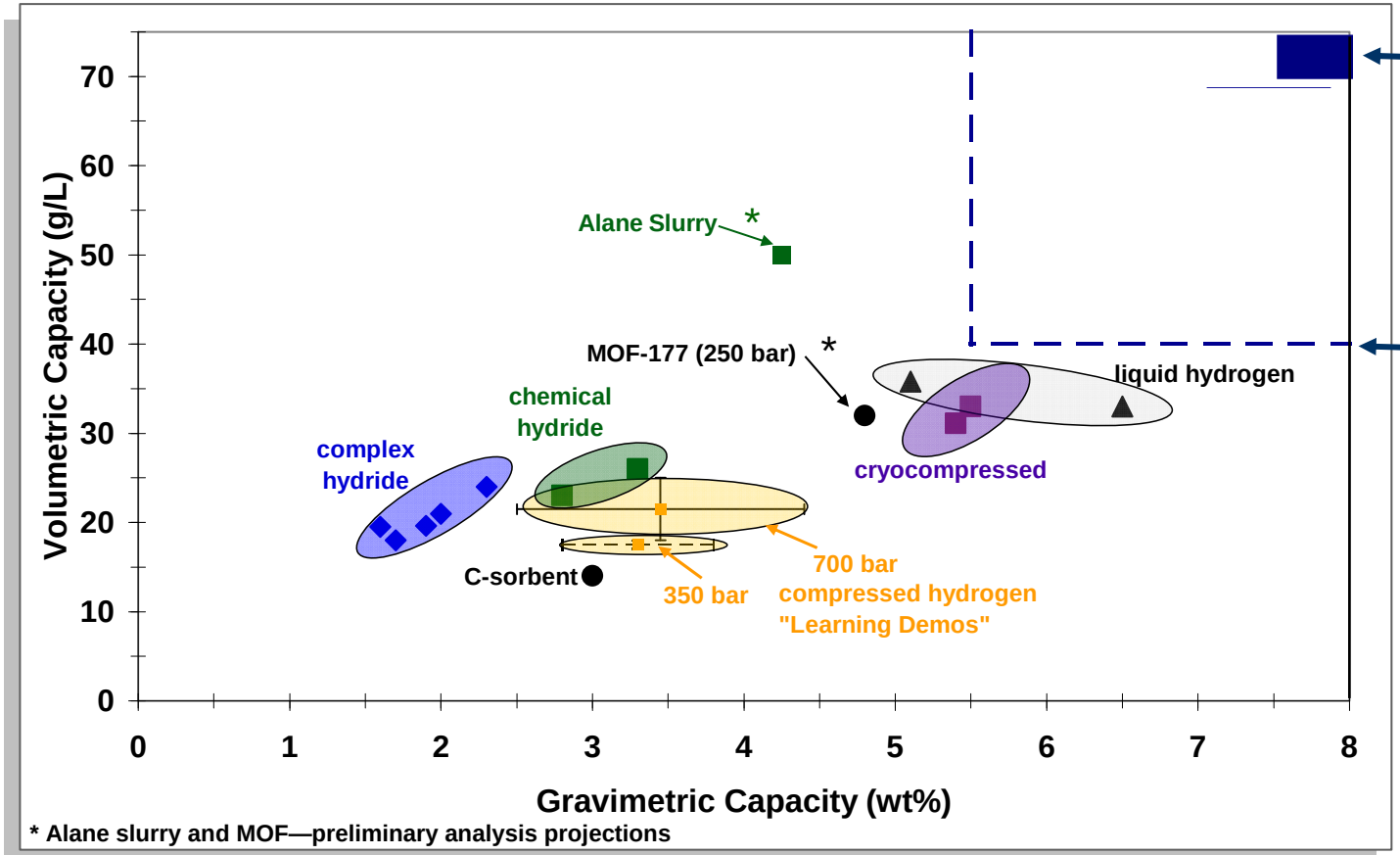
We've reduced the cost of hydrogen delivery —**

- *~30% reduction in tube trailer costs*
- *>10% reduction in pipeline costs*

***modeled cost, based on analysis of state-of-the-art technology*



H_2 Storage R&D — *Status & Accomplishments*



New "ultimate" targets

7.5 wt%, 70 g/L

Revised 2015 targets

5.5 wt%, 40 g/L

- **Assessed and updated targets as planned** (based on real-world experience with vehicles, weight & space in vehicle platform, and needs for market penetration)
- **Developed and evaluated more than 200 materials approaches**
- **Launched New Storage Engineering Center of Excellence** to address systems integration and prototype development—efforts coordinated with materials centers

Technology Validation — *Accomplishments*

DOE Vehicle/Infrastructure Demonstration

(four teams in 50/50 cost-shared projects with DOE Vehicle Technologies Program)

Validated performance in
140 fuel cell vehicles
and 20 hydrogen stations:

More than 1.9 million miles traveled and 90,000 kg hydrogen produced/dispensed (Analysis by NREL)

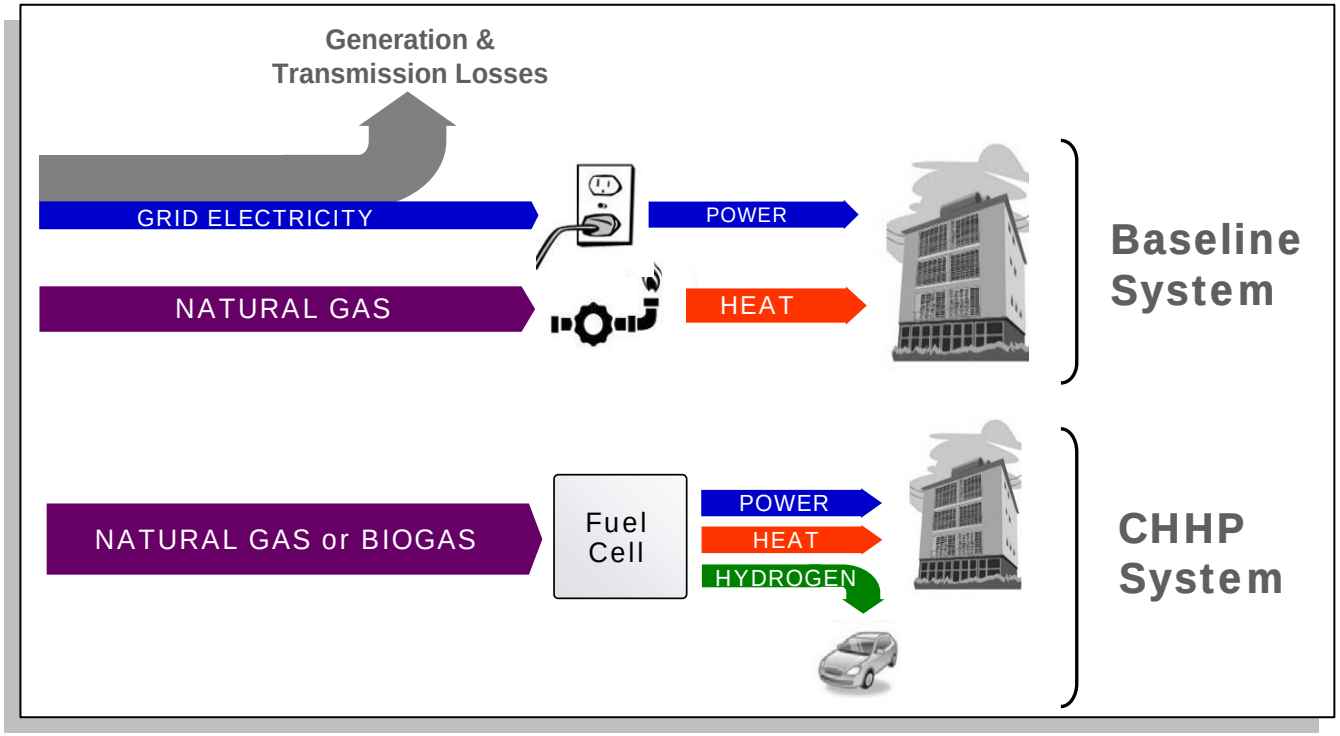
- **EFFICIENCY: 53 – 58%** (>2x higher than gasoline internal combustion engines)
- **RANGE: ~196 – 254 miles**
- **FUEL CELL SYSTEM DURABILITY:**
  - **Nearly 2,000 hrs (~60,000 miles)**

Evaluating real-world forklift and bus fleet data (DOD and DOT collaboration)

Potential Early Market Application — *CHHP Accomplishments*

Combined heat, hydrogen, and power systems (CHHP) can:

- ***Produce clean power and fuel for multiple applications***
- ***Provide a potential approach to establishing an initial fueling infrastructure***



CHHP Project is Underway:

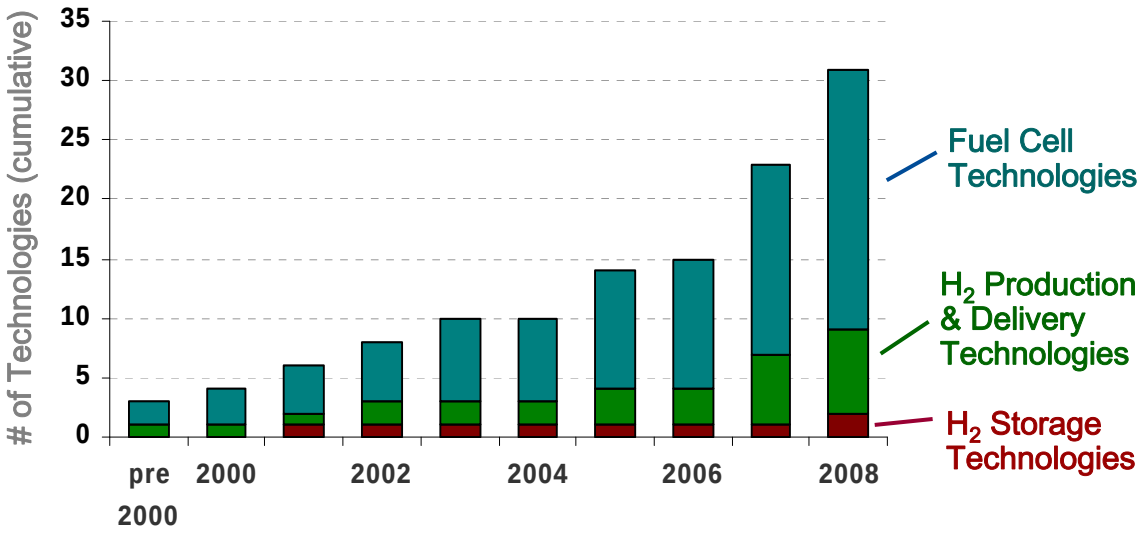
Orange County Sanitation District in Fountain Valley, CA—Air Products & FuelCell Energy

- **System has been designed, fabricated and shop-tested.**
- **Improvements in design have led to higher H_2-recovery (from 75% to >85%).**
- **On-site operation and data-collection planned for FY09 – FY10.**

Pacific Northwest National Lab is tracking the commercial success of technologies developed by the Program.

Accelerating Commercialization:

An increasing number of HFCIT-funded technologies have been entering the market.



PATENTS resulting from HFCIT-funded R&D:

118 patents reviewed:

- 60 fuel cell patents
- 37 hydrogen production/delivery patents
- 21 storage patents

Results will be documented in a report:

"Pathways to Commercial Success: Technologies and Products Supported by the Hydrogen, Fuel Cell Infrastructure Technology Program"

Market Transformation - *Accomplishments*

We are facilitating the adoption of fuel cells across government and industry.

RECENT ACCOMPLISHMENTS

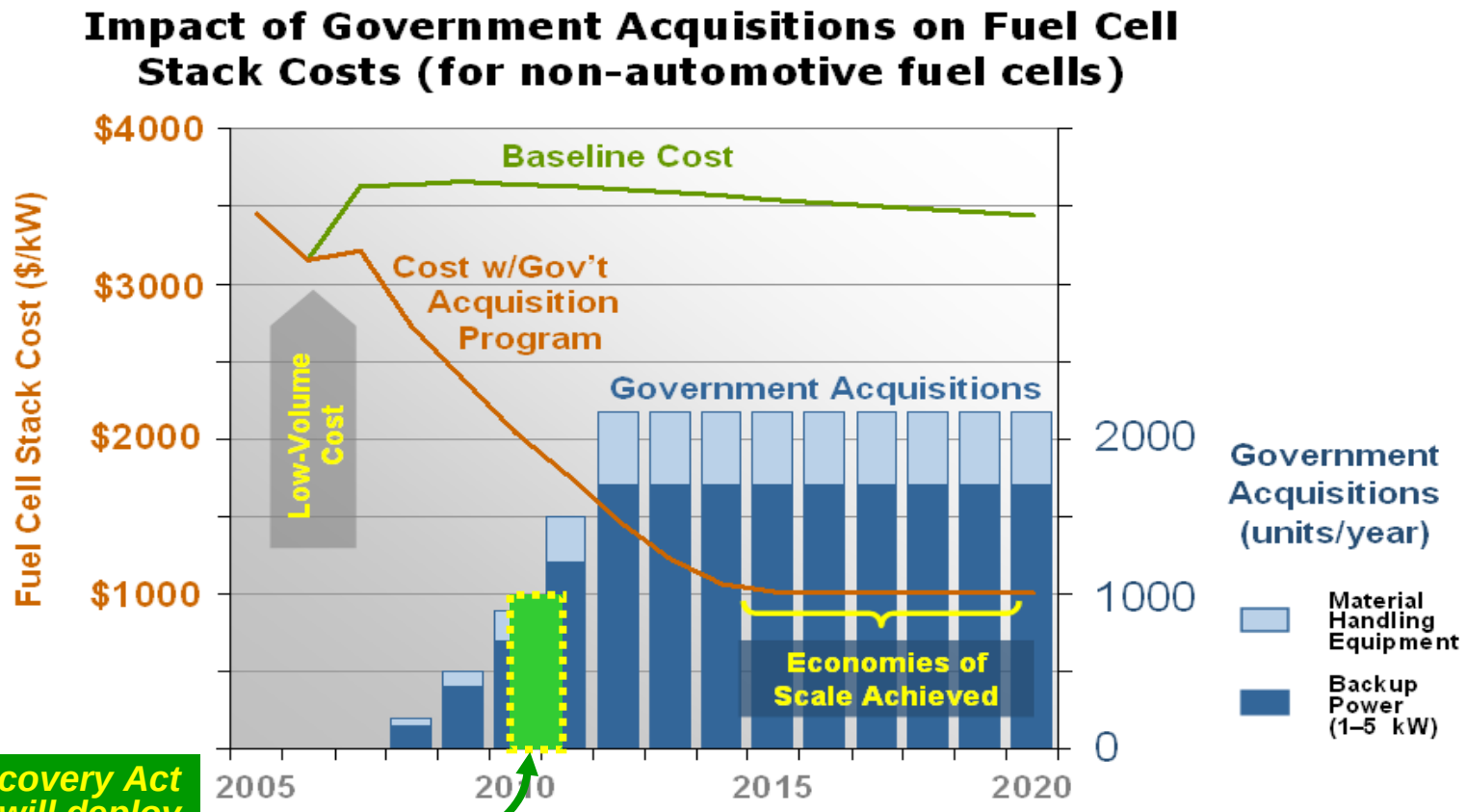
Leveraging federal collaborations:

- ***Interagency agreements under development***
  - Deployment of up to 100 fuel cells underway
  - Army Construction Engineering Research Lab, Federal Aviation Administration, Department of Homeland Security, Office of Naval Research
- ***Developed Investment Tax Credit fact sheet and case studies***
- ***Identifying locations for fuel cells in federal facilities***

40 fuel cell forklifts are in operation at the Defense Logistics Agency, Defense Depot Susquehanna, PA.

Market Transformation

Government acquisitions could significantly reduce the cost of fuel cells through economies of scale, and help to support a growing supplier base.



Recovery Act funding will deploy up to 1000 fuel cells, in the private sector, by 2012.

Source: ORNL

We are facilitating the adoption of fuel cells across government and industry:

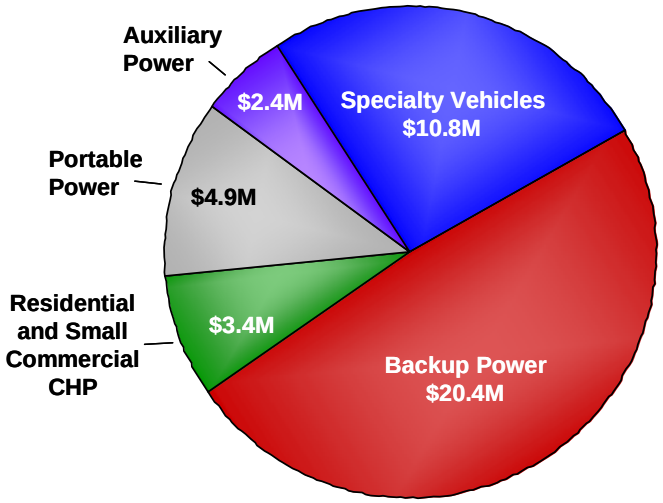
- **100 fuel cells are being deployed, through interagency agreements.**
- **More interagency agreements under development.**

Recovery Act - Funding for Fuel Cells

DOE announced $41.9 million from the American Recovery and Reinvestment Act to fund 13 projects to deploy more than 1,000 fuel cells — to help achieve near term impact and create jobs in fuel cell manufacturing, installation, maintenance & support service sectors.

FROM the LABORATORY to DEPLOYMENT:

DOE funding has supported R&D by all of the fuel cell suppliers involved in these projects.



Approximately $72.4 million in cost-share funding from industry participants—for a total of nearly $114.3 million.

COMPANY	AWARD	APPLICATION
Anheuser-Busch	$1.1 M	Specialty Vehicle
Delphi Automotive	$2.4 M	Auxiliary Power
FedEx Freight East	$1.3 M	Specialty Vehicle
GENCO	$6.1 M	Specialty Vehicle
Jadoo Power	$1.8 M	Backup Power
MTI MicroFuel Cells	$2.4 M	Portable
Nuvera Fuel Cells	$1.1 M	Specialty Vehicle
Plug Power, Inc. (1)	$3.4 M	CHP
Plug Power, Inc. (2)	$2.7 M	Backup Power
PolyFuel, Inc.	$2.5 M	Portable
ReliOn Inc.	$8.6 M	Backup Power
Sprint Comm.	$7.3 M	Backup Power
Sysco of Houston	$1.2 M	Specialty Vehicle

Recovery Act - Grants in Lieu of Tax Credits

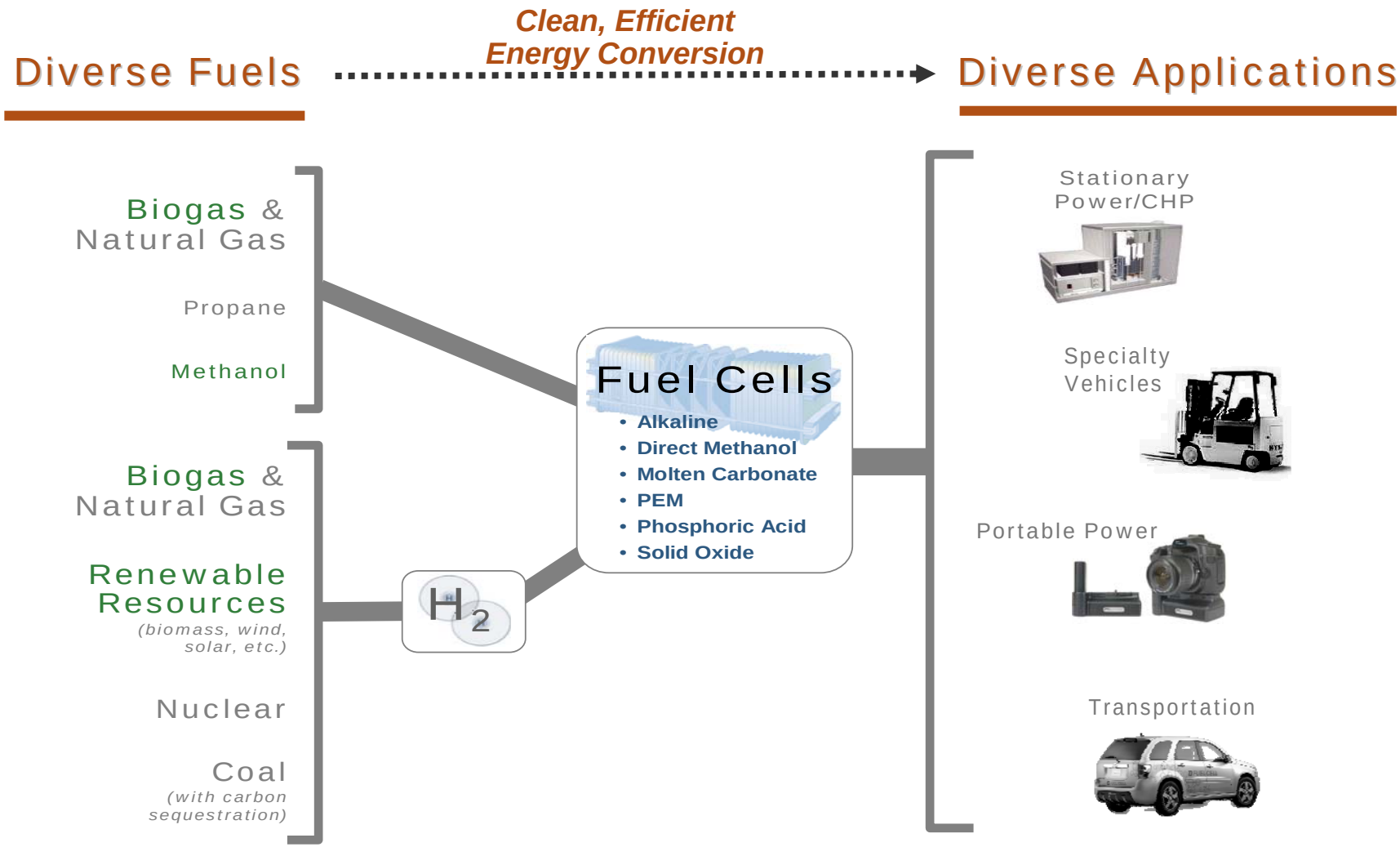
Section 1603: Payments for Specified Property in Lieu of Tax Credits

- DOE and Treasury Department ARRA funds are available for renewable energy projects.
- Provides direct payments in lieu of tax credits for projects using 15 EERE technologies, including solar, wind, geothermal, microturbines, and fuel cells.
- Grants provide 30% or $3000/kW grant funding, whichever is LOWER.
- Project must be in service or in construction in 2009 or 2010, and projects with multiple qualified technologies are acceptable.
- Applications will start being accepted and processed Aug. 1, 2009, recipients are to be notified within 60 days.
- There are no limits on the number of projects or funding.

- Email for Q and A: 1603questions@do.treas.gov
- Press release: http://www.treasury.gov/press/releases/tg202.htm
- Documents including Guidance, Terms and Conditions, and Sample Application Form: http://www.treasury.gov/recovery/1603.shtml

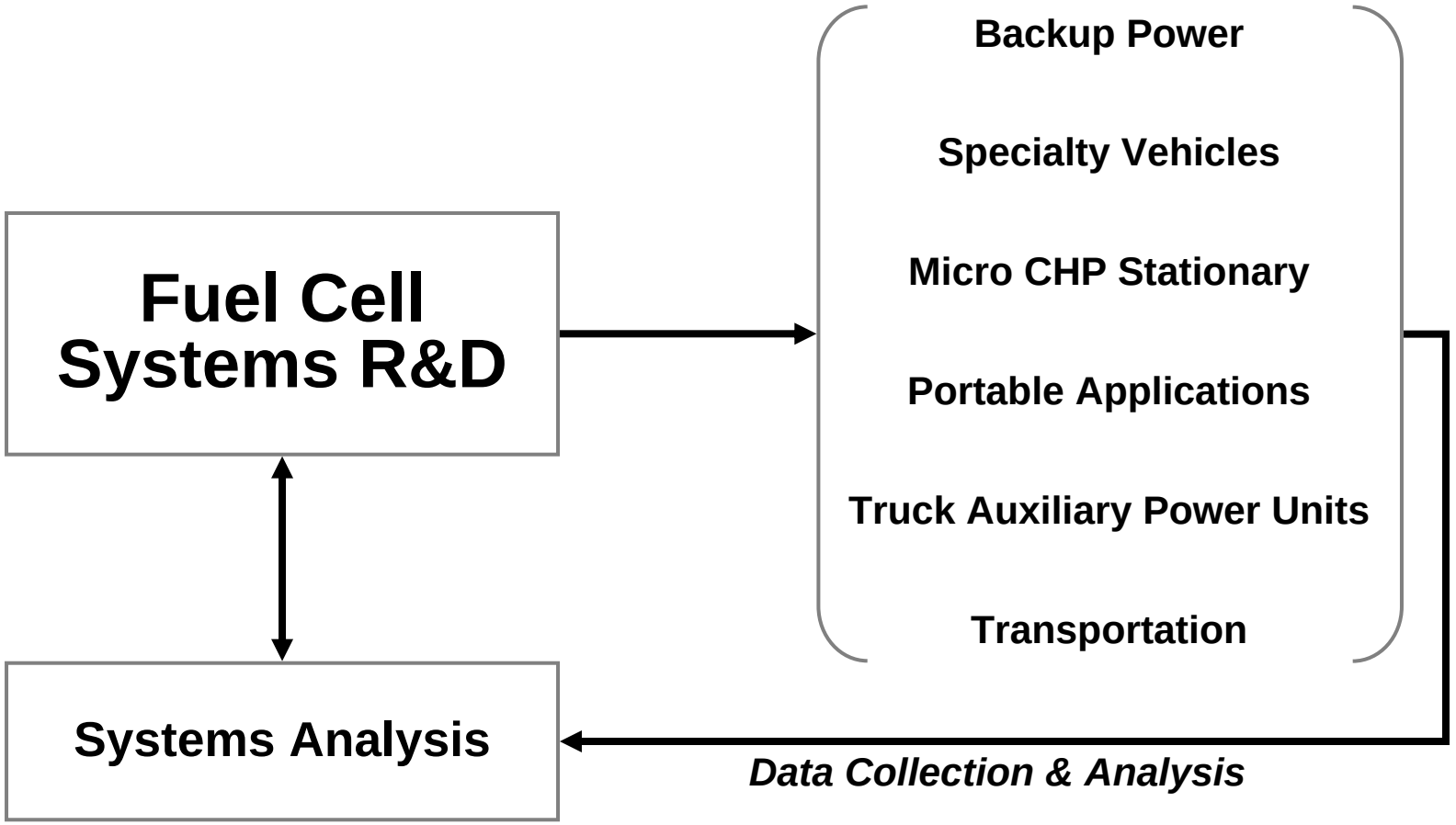
New Program Focus — *The Role of Fuel Cells*

- ***Fuel cells offer a** highly efficient **way to use diverse fuels and energy sources.***
- ***Fuel cells can be powered by** emissions-free fuels **that are produced from** clean, domestic **resources.***



New Program Structure

The Program will refocus on technology-neutral Fuel Cell Systems R&D and Systems Analysis to prioritize research & quantify impacts/benefits.



Request for Information (RFI) on Targets for Combined Heat and Power (CHP) and Auxiliary Power Units (APUs)

- **Opportunity for stakeholder and developer input**
- **Examples of information requested:**
  - ***Relevance of the proposed targets***
  - ***Recommendations for testing conditions and protocols***
  - ***Adequacy of target table explanations and/or need for additional supporting information***
  - ***Need for thermal cycling or on/off cycling durability targets***
  - ***Recommendations for additional targets***
  - ***Current status compared to targets & potential areas of R&D***

RFI closed June 30, 2009

Budget — *EERE Key Activities*

EERE Hydrogen and Fuel Cells Budget (in thousands)						
Key Activity	**FY 2007** *approp.*	**FY 2008** *approp.*	**FY 2009** *approp.*	**FY 2010** *request*	***FY2010*** *House*	***FY2010*** *Senate*
Fuel Cell Systems R&D	-	-	-	63,213	63,213	TBD
Hydrogen Transportation Systems	-	-	-	-	40,000 *	TBD
Hydrogen Production & Delivery R&D	33,702	38,607	10,000	-	-	TBD
Hydrogen Storage R&D	33,728	42,371	59,200	-	-	TBD
Fuel Cell Stack Component R&D	37,100	42,344	62,700	-	-	TBD
Technology Validation	39,413	29,612	14,789*	-	-	TBD
Transportation Fuel Cell Systems	7,324	7,718	6,600	-	-	TBD
Distributed Energy Fuel Cell Systems	7,257	7,461	10,000	-	-	TBD
Fuel Processor R&D	3,952	2,896	3,000	-	-	TBD
Safety, Codes & Standards	13,492	15,442	12,500*	-	-	TBD
Education	1,978	3,865	4,200*	-	-	TBD
Systems Analysis	9,637	11,099	7,713	5,000	5,000	TBD
Manufacturing R&D	1,928	4,826	5,000	-	-	TBD
Market Transformation	-	-	4,747	-	-	TBD
Total	**$189,511**	**$206,241**	**$200,449**	**$68,213**	**$108,213**	**$190,000**

*** Under Vehicle Technologies Budget**

Legislative Update – *House Appropriations*

The Appropriations committees of both houses of Congress have marked up the FY2010 budget.

House

- **July 8, 2009: The House Appropriations Committee mark included $40 million for hydrogen transportation systems (under Vehicle Technologies), in addition to the $68.2 million requested.**

> "The Committee recommendation provides $40,000,000 in Vehicle Technologies for hydrogen transportation systems RDD&D activities, to include hydrogen delivery, storage, and fuel cell systems, for overcoming technology, infrastructure, and manufacturing barriers to widespread deployment of transportation vehicles using hydrogen as fuel. The budget request eliminated funding for these activities from within the former Hydrogen Technologies program. To be consistent with the Department's position of investment in a portfolio of energy solutions with a broad range of risk profiles and payback periods, the Committee recommends maintaining a level of investment in this program, as one of a number of vehicle technologies supported by the Department, commensurate with the potential long term benefits of widespread adoption of hydrogen transportation technologies."

Legislative Update – *Senate Appropriations*

Senate

- **July 9: The Senate Appropriations Committee mark included $190 million for continuation of the hydrogen R&D program.**

"Hydrogen Technology- The Committee recommends $190,000,000, all above the request of $0, to continue funding 189 contracts the Department has in place for fiscal year 2010, saving approximately 140 jobs at universities, 150 at Federal laboratories, and 235 jobs within industry. The Committee provides additional funds to enable fuel research and development, early market deployments, transformation, and enabling activities in transportation applications. The Committee also looks forward to the 2009 release of the updated Hydrogen Program Plan, and encourages the Secretary to consider it more carefully as the fiscal year 2011 program budget is developed.

Fuel Cell Technologies-The Committee recommends $0, rather than $68,213,000, as requested, for Fuel Cell Technologies. Fuel cell technology can continue to be pursued under the Hydrogen Technology program in fiscal year 2010 as it has been in the past."

Final conference mark anticipated ~ September (TBD)

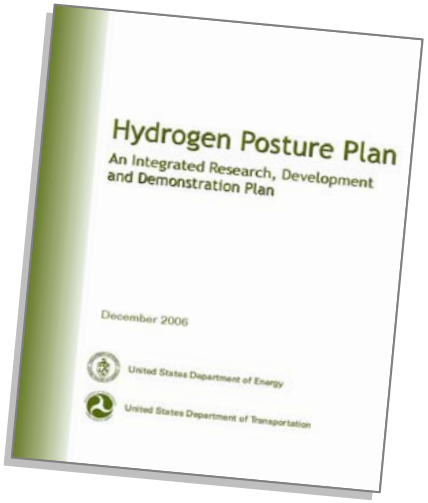
House Climate Bill - *Fuel Cell-Related Provisions*

H.R. 2454, The American Clean Energy and Security Act was passed by the House on June 26, 2009

- **Fuel cells are covered by the Renewable Electricity Standard**
  - **Non-combustion renewable distributed generation facilities are capped at 4MW (compared to 2MW for other DG) under the RES standard.**
  - **Biogas, wastewater treatment gas, and landfill gas are considered renewable resources.**
  - **Energy savings resulting from fuel cells can be included as a part of the electricity savings that can compose up to 25% of the RES renewable requirement.**
- **Fuel cells are included in the definition of a "clean energy product," meaning manufacturers are eligible for State Grant programs.**

Program Priorities and Next Steps

- **Publications**
  - **Fuel Cell Program Plan (replacement of current Posture Plan)**
  - **Publication of National Action Plan, detailing interagency coordination.**
- **NAS study entitled "Assessment of Resource Needs for Development of Fuel Cell and Hydrogen Technology" to be updated to include PHEVs and published in September 2009***
- **Continued market and benefits analysis**
- **Continued incorporation of feedback from stakeholders**



*http://www8.nationalacademies.org/cp/projectview.aspx?key=48717

Examples of Activities in Other Agencies

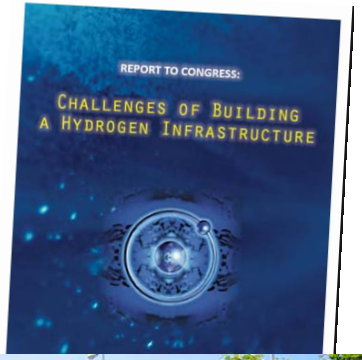
CHP	Tri-gen pilot at Fort Lewis, WA using WWTP digester gas.
Portable	Some soldier fuel cells/APUs being field tested.
Backup	49 5-kW units planned at various Army locations.
Material Handling	DLA – 40 fuel cell forklifts deployed at 3 locations (60 more planned).
Transp.	Fuel cell buses at Norfolk, VA and Warner Robins, GA.

Backup Power	16 5-kW backup power units to support National Weather Service atmosphere modeling.

Stationary Power	2 5-kW SOFCs at a National Park in OH, providing grid-independent power.

Examples of Activities in Other Agencies

Backup	24 fuel cells for remote telecom backup (FAA).
Transp.	National Fuel Cell Bus demonstration; recent report to congress on infrastructure.



Stationary/ Backup	8 Plug Power units in field test at the Glenn Research Center in Cleveland, OH.

CHP	250-kW fuel cell for CHP at mail processing facility in CA.
Transp.	Fuel cell vehicles used for mail distribution in CA and VA.

Backup	5-kw fuel cell for backup power at Denver Federal Center.
Other	New “Innovative Energy Solutions” Schedule makes it easier for Federal Agencies to purchase fuel cell systems.

Additional Information

Hydrogen & Fuel Cell Budgets: *FY04 – FY10*

	Funding *($ in thousands)*						
	FY 2006 Approp.	FY 2007 Approp.	FY 2008 Approp.	FY 2009 Approp.	FY 2010 Request	FY 2010 House Mark	FY 2010 Senate Mark
EERE Hydrogen/Fuel Cells	153,451	189,511	206,241	200,449	68,213	108,213	190,000
Fossil Energy (FE)	21,036	21,513	24,088	25,000*	16,400*	16,400*	26,400*§
Nuclear Energy (NE)	24,057	18,855	9,668	7,500	0	0	0
Science (SC)	32,500	36,388	36,509	36,509	36,509**	TBD	TBD
DOE TOTAL	**231,044**	**266,267**	**276,506**	**269,458**	**121,122**		
Department of Transportation (DOT)	1,411	1,420	1,425	1,400	500	TBD	TBD
TOTAL	**232,455**	**267,687**	**277,931**	**271,258**	**122,922**		

*** Includes funding for R&D plus program direction. Fossil Energy also plans $58M for SECA in FY10.**
**** The Office of Science also plans ~$14M for Biological and Environmental Research in FY10.**
§Includes funding for coal to hydrogen and coal to liquids.

Secretary's Budget Strategy

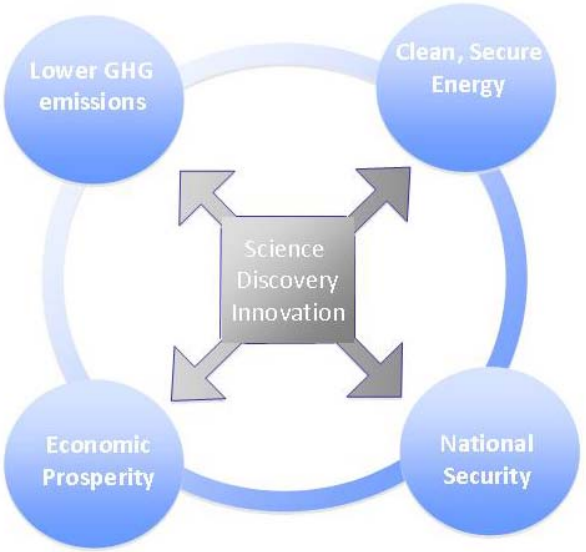
What is the benefit and does it advance DOE goals?

- ***Significant impact on economic prosperity, GHG emissions, and national security***
- ***Meaningful science – taking risks for breakthrough results***
- ***Open to partnerships with other programs, industry, and/or international partners***

1. **Is the proposed spending likely to have transformative impacts?**
   - Create jobs
   - Avoid GHG emissions
   - Decrease oil imports

2. **How close are we to technology innovation, demonstration, and deployment?**
   - Near term: Less than 5 years
   - Mid-term: 5-15 years
   - Long-term: 15+ years

3. **Are we making the appropriate risk/benefit analysis?**
   - Transformational solutions are generally higher risk than incremental improvements
   - Are we searching for solutions that will have significant (material) impact?
   - Will (or could) the solution be cost-effective?



Legislative Update – *Climate Bill*

H.R. 2454, The American Clean Energy and Security Act was passed by the House on June 26, 2009

- **Sets a goal of reducing greenhouse gases by 17 percent below 2005 levels by 2020, and 83 percent by 2050.**
- **Establishes a cap and trade regime for carbon emissions and a renewable electricity standard.**
- **Invests $190 billion in new clean energy technologies and energy efficiency, including energy efficiency and renewable energy ($90 billion in new investments by 2025), carbon capture and sequestration ($60 billion), electric and other advanced technology vehicles ($20 billion), and basic scientific research and development ($20 billion).**
- **Mandates new energy-saving standards for buildings, appliances, and industry**

Senate action

- Climate change bill hearing was held July 7 by the Energy & Public Works Committee
- Senate committee report on the "American Clean Energy Leadership Act of 2009" to be published this week.
- Energy/climate action is expected to take a back seat to Supreme Court confirmation, August recess, and healthcare

New Recovery Act Projects

Deploying Fuel Cells for Specialty Vehicles

Anheuser-Busch (St. Louis, MO)	**$1.1 million**	***23 fuel cells in class-1 lift trucks***
FedEx Freight East (Harrison, AR)	**$1.3 million**	***35 fuel cells in class-1 lift trucks***
GENCO (Pittsburgh, PA)	**$6.1 million**	***156 fuel cells in six fleets of class-1 and class-3 lift trucks***
Nuvera Fuel Cells (Billerica, MA)	**$1.1 million**	***Supplement a fuel cell forklift fleet with 10 fuel cell power packs and a hydrogen fueling system***
Sysco of Houston (West Houston, TX)	**$1.2 million**	***90 fuel cells in class-3 pallet trucks***

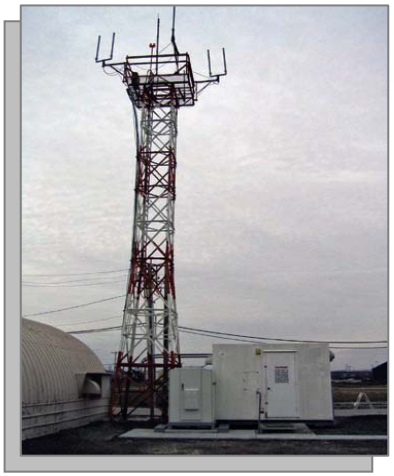
TOTAL: **$10.8 million**

Advantages of Fuel Cells for Specialty Vehicles:

- Allow for rapid refueling — much faster than changing-out or recharging batteries *(refueling takes about one minute, while battery changes can take 20 – 45 minutes, and recharging can take anywhere from 2 to 16 hours)*
- Provide constant power without voltage drop
- Eliminate space requirements of batteries & chargers
- Can provide ***substantial cost-savings*** over battery-powered forklifts (more than 50% reduction in lifecycle costs for a 3-kW pallet truck)

New Recovery Act Projects

Deploying Fuel Cells for Back-up Power



Plug Power (Latham, NY)	**$2.7 million**	• *Up to 275 kW at government sites*
ReliOn Inc. (Spokane, WA)	**$8.6 million**	• *25 sites in utility communications network* • *180 installations for telecommunications network*
Sprint (Reston, VA)	**$7.3 million**	• *1- to 10-kW fuel cells for state/local first responders*
Jadoo Power (Folsom, CA)	**$1.8 million**	• *Evaluation of environmental and cost benefits of using 1-kW fuel cell, as opposed to gas/diesel generators and batteries*

TOTAL: **$20.4 million**

Advantages of Fuel Cells for Backup Power:

- **Provide longer continuous run-time, greater durability than batteries** *(Battery systems usually run 4 – 8 hrs, and have to be replaced every 3 – 5 years, while fuel cell runtime is limited only by storage capacity, and they could last 15 years or more, depending on amount of actual use.)*
- **Require less maintenance than batteries or generators** *(estimated routine maintenance of two hours per year for fuel cells and eight hours per year for batteries and generators)*
- **Can be remotely monitored**
- **Can provide substantial cost-savings over battery-generator systems** *(nearly 25% reduction in lifecycle costs for a 5-kW, 52-hour backup-power system)*

New Recovery Act Projects

Demonstrating PEM Fuel Cells for Residential and Small Commercial CHP

ADVANTAGES of FUEL CELLS for CHP...

- **Up to 85% overall efficiency**
- **25 – 35% reduction in emissions from household energy use**
- **Zero emissions**
- **Low noise and vibration**
- **Low O&M requirements, less down-time**
  - ***100x more reliable than the average power supply for data centers—three seconds of down time per year versus an average of five minutes***
- **Less variation in efficiency across variable loads**

Plug Power, Inc. (Latham, NY)	**$3.4 million**	***5-kW stationary CHP systems***

Plug Power's GenSys Blue, for residential and small commercial applications

New Recovery Act Projects

Deploying Fuel Cells for Portable Power

MTI MicroFuel Cells (Albany, NY)	**$2.4 million**	• *1-W consumer electronics power pack*
PolyFuel, Inc. (Mountain View, CA)	**$2.5 million**	• *Portable power system for mobile computing*
TOTAL:	**$4.9 million**	

Deploying Fuel Cells for Auxiliary Power

Delphi Automotive (Troy, MI)	**$2.4 million**	• *3- to 5-kW SOFC APUs for heavy-duty class-8 trucks*

Recovery Act Tax Credits

Some tax credits affecting fuel cells were expanded. Through new financing mechanisms, these credits can help facilitate federal deployments.

Hydrogen Fueling Facility Credit	**Increases the hydrogen fueling credit from 30% or $30,000 to 30% or $200,000.**
Grants for Energy Property in Lieu of Tax Credits	**Allows facilities with insufficient tax liability to apply for a grant instead of claiming the Investment Tax Credit (ITC) or Production Tax Credit (PTC). Only entities that pay taxes are eligible.**
Manufacturing Credit	**Creates 30% credit for investment in property used for manufacturing fuel cells and other technologies**
Residential Energy Efficiency Credit	**Raises ITC dollar cap for residential fuel cells in joint occupancy dwellings to $3,334/kW.**

International Issues —
International Partnership for the Hydrogen Economy (IPHE)

We need to ensure that our work with IPHE reflects the administration's priorities—to continue to benefit the FCT Program.

ABOUT the IPHE

- **IPHE facilitates international collaboration activities to enhance development of hydrogen and fuel cell technologies.**
  - Steering Committee (SC) = Policy Level
  - Implementation – Liaison Committee (ILC) = Technical Level
  - Secretariat = Canada lead with U.S. website support

NEW DIRECTIONS

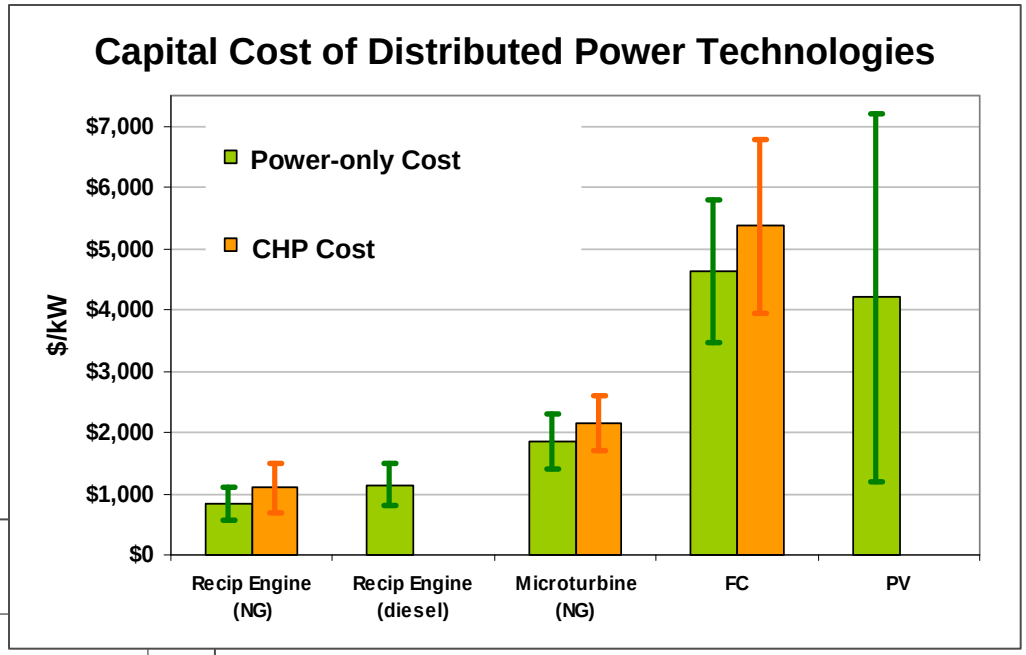
- **IPHE has been increasing focus on fuel cells for stationary, portable, and material handling applications**
- **U.S. has proposed a name change to "International Partnership for Hydrogen and Fuel Cells in the Economy"**

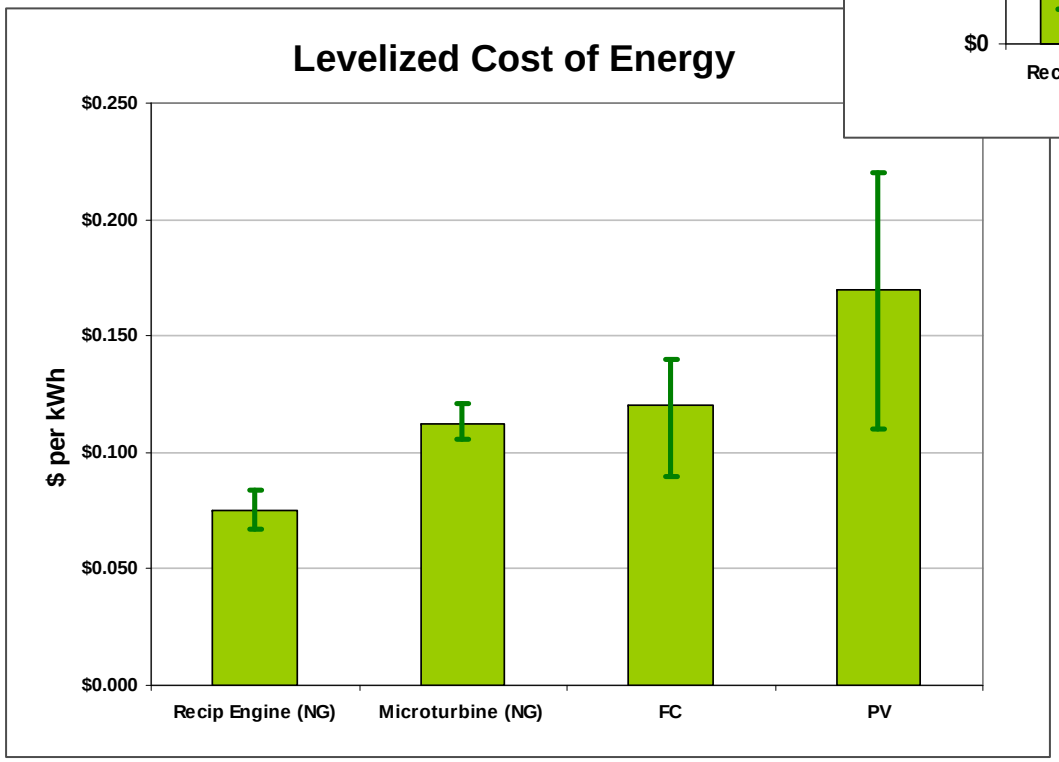
2009 Meetings:

- ILC – Oslo, Norway in March 2009
- SC – Uluru, Australia in May 2009
- **U.S. hosting joint SC and ILC meeting in December 2009 in DC**
  - Finalize Policy Brief and *Status of Member's Technology Progress*
  - Transfer Chair of SC and Secretariat from Canada to Germany

Mission — *Comparison with Other Technologies*

Fuel cells can provide clean, reliable power, and they are starting to become competitive with other distributed power-generation technologies.

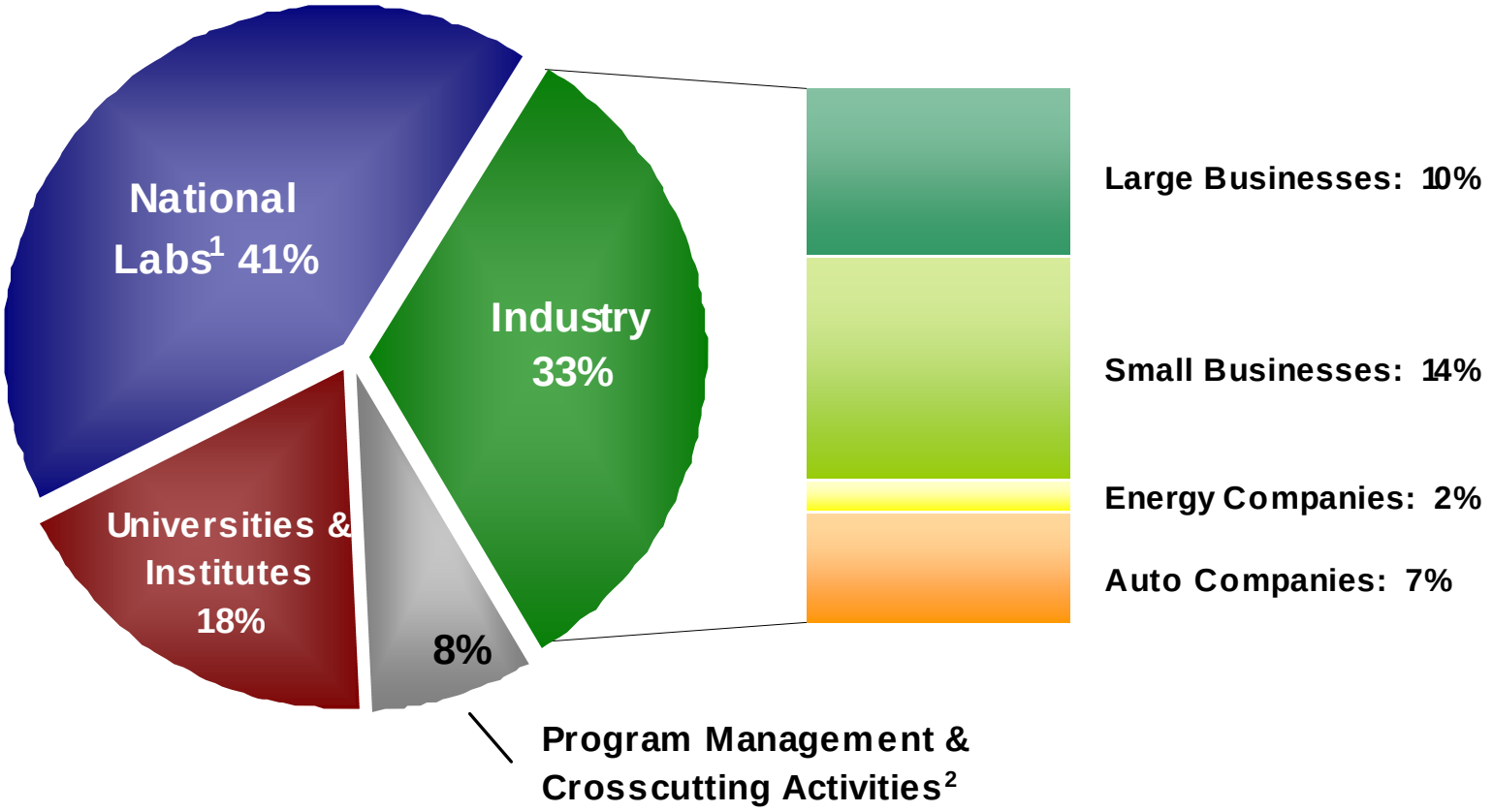




Sources: NREL, EPA, DOE, and Navigant Consulting

FY 2008 - *Spending Distribution*

Total FY08 Budget: $276.5 M



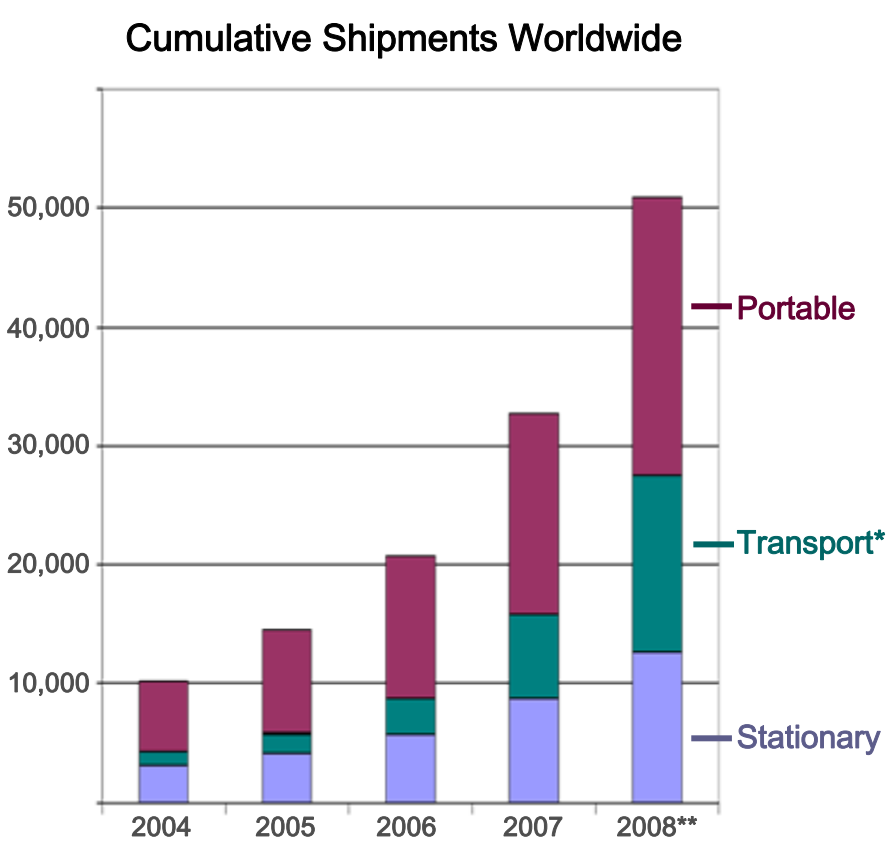
*In FY 2008, **$191 million** in funding went to competitively selected projects, 76% of a total of $252 million in R&D project funding.*

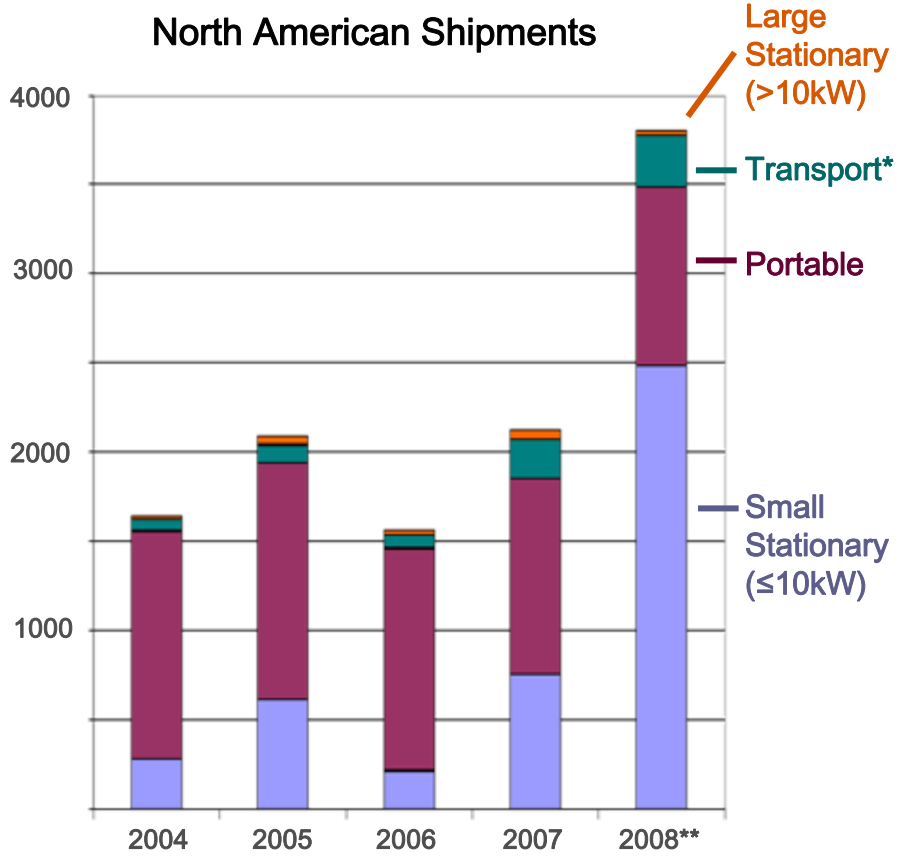
[1] *"National Labs" includes DOE labs as well as other federal labs, such as NIST, JPL, etc.*

[2] *"Program Management & Crosscutting Activities" includes various support activities, such as the Annual Merit Review, required EPACT studies and reports, etc.*

Status of Fuel Cells — *Growing Markets*

The fuel cell industry has grown more than 50% annually over the past four years, with the majority of sales in markets for stationary power, auxiliary power, specialty vehicles, and portable power.





Source: Fuel Cell Today

* "Transport" includes specialty vehicles (e.g., forklifts) and auxiliary power units, which currently account for most of the sales in that sector.

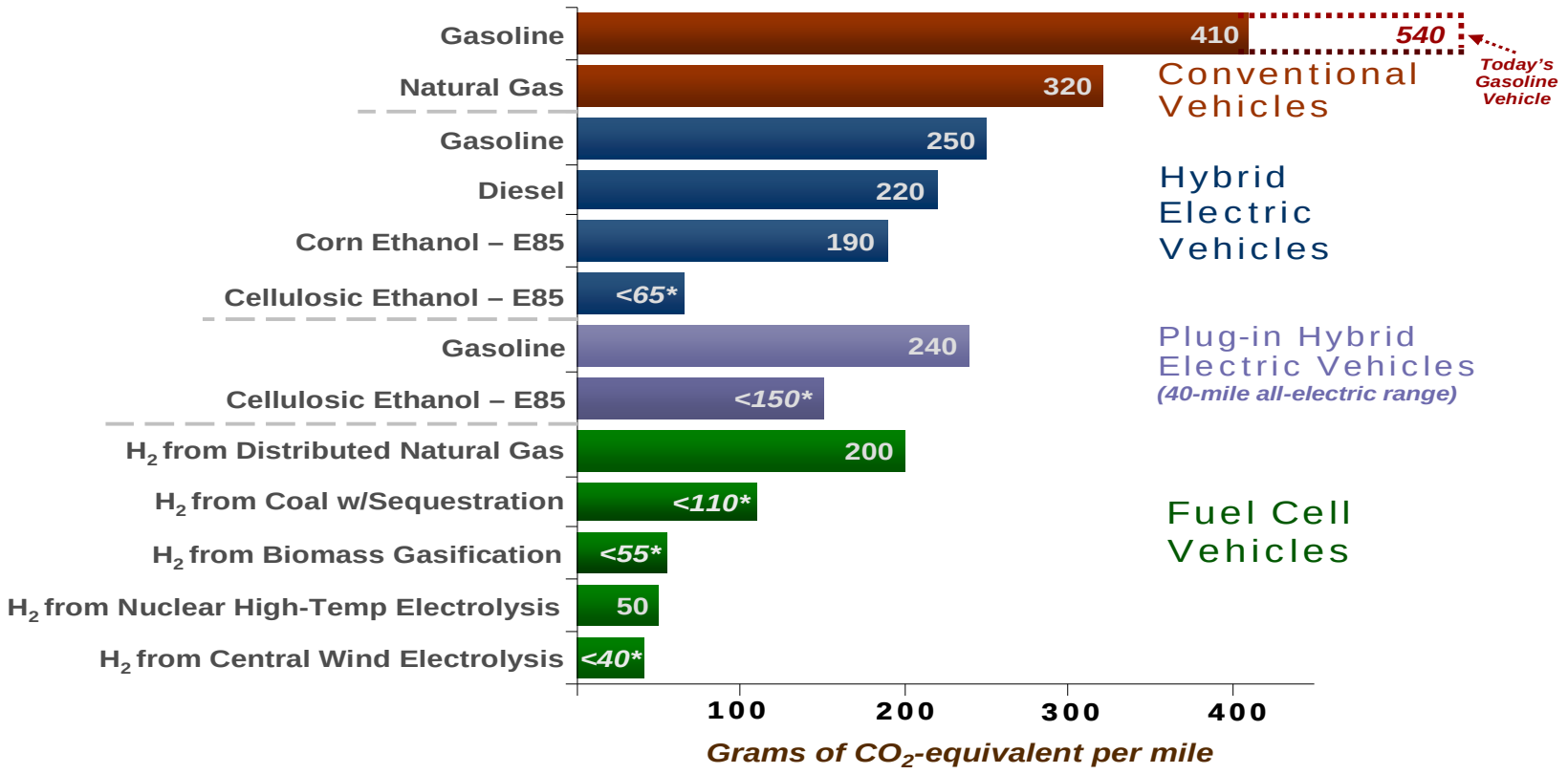
** 2008 numbers are preliminary estimates.

Systems Analysis — *Greenhouse Gas Emissions*

Analysis shows DOE's portfolio of transportation technologies will reduce emissions of greenhouse gases.

Well-to-Wheels Greenhouse Gas Emissions

(life cycle emissions, based on a projected state of the technologies in 2020)



***Net emissions from these pathways will be lower if these figures are adjusted to include:**

- The displacement of emissions from grid power–generation that *will* occur when surplus electricity is co-produced with cellulosic ethanol
- The displacement of emissions from grid power–generation that *may* occur if electricity is co-produced with hydrogen in the biomass and coal pathways, and if surplus wind power is generated in the wind-to-hydrogen pathway
- Carbon dioxide sequestration in the biomass-to-hydrogen process

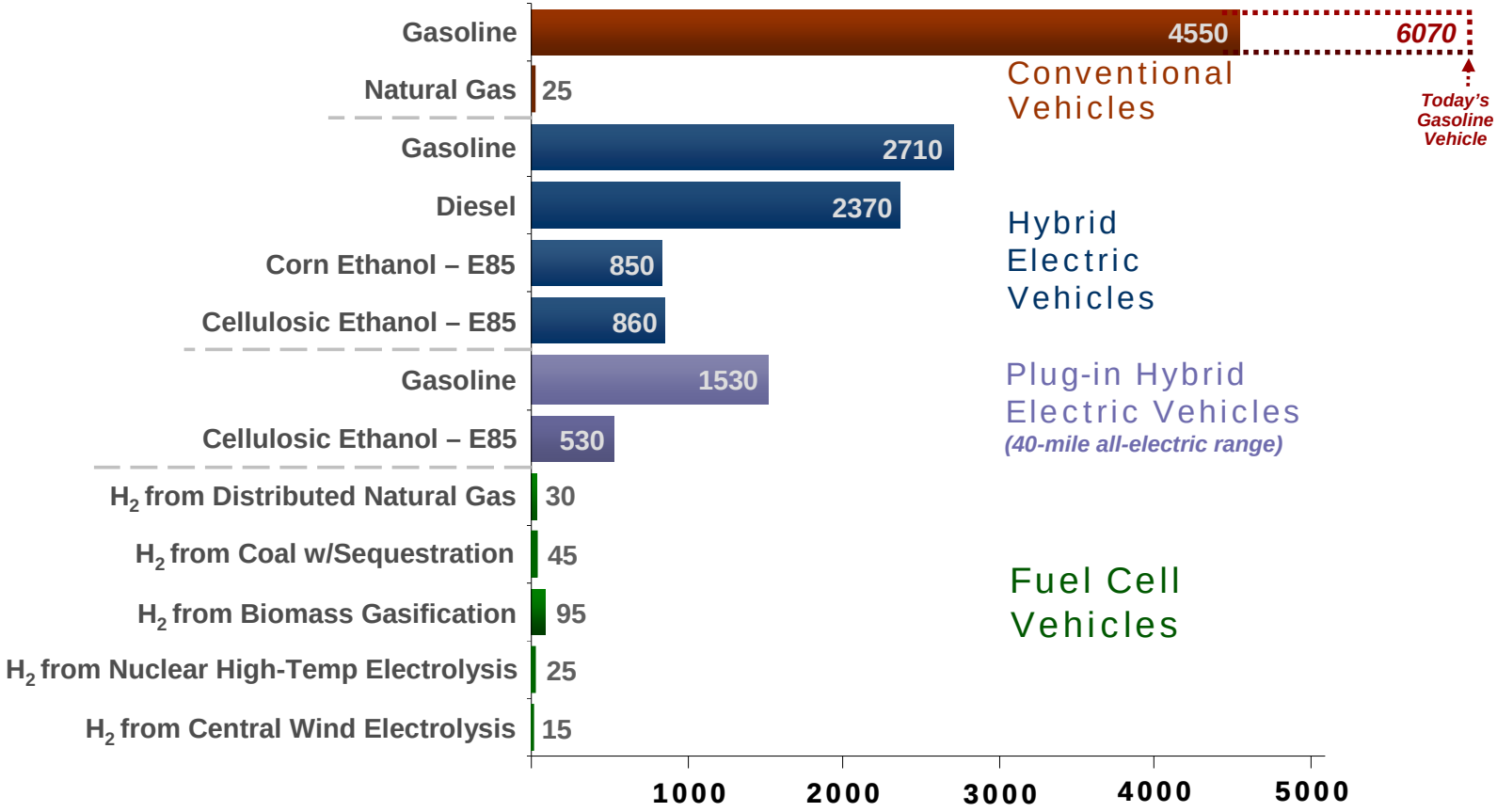
Program Record #9002, www.hydrogen.energy.gov/program_records.html.

Systems Analysis — *Petroleum Use*

Analysis shows DOE's portfolio of transportation technologies will reduce oil consumption.

Well-to-Wheels Petroleum Energy Use

(based on a projected state of the technologies in 2020)

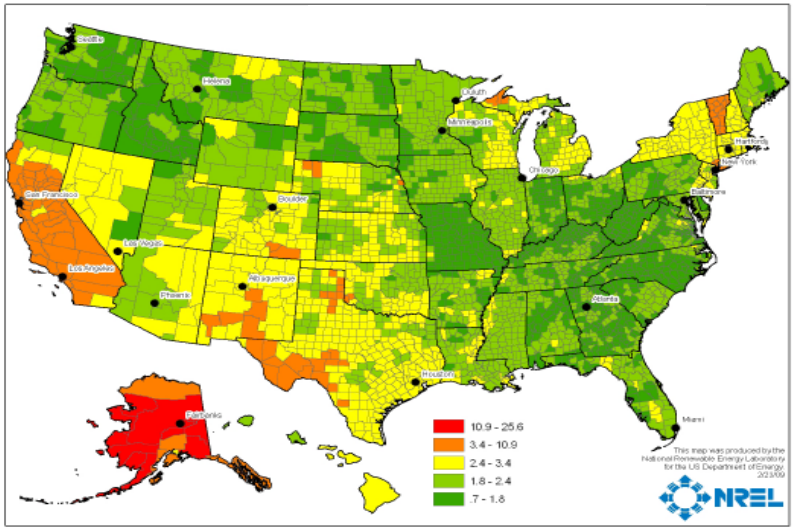


Program Record #9002, www.hydrogen.energy.gov/program_records.html.

Systems Analysis

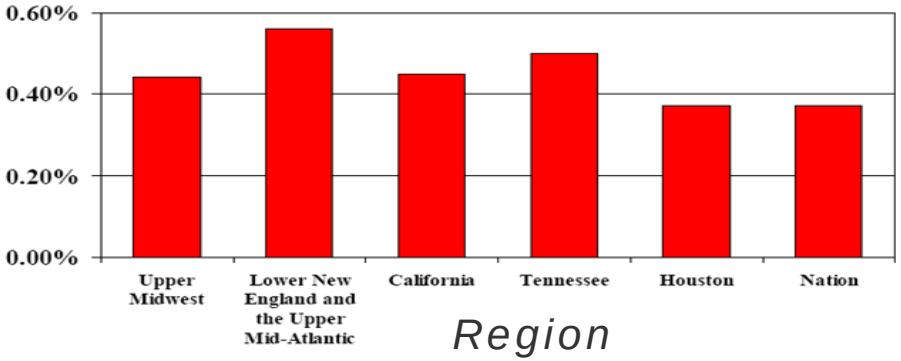
We are assessing the costs and benefits of various technology pathways and identifying key technological gaps, by conducting:

Life-cycle analysis, Emissions analysis, Environmental analysis, Systems integration analysis

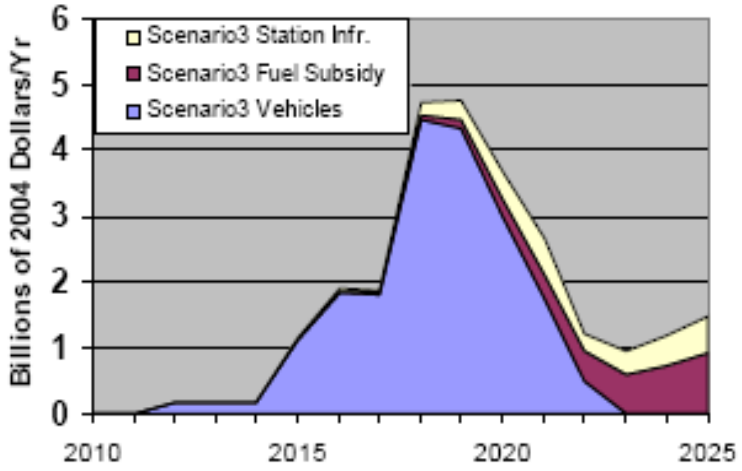


Areas with a high ratio of electricity cost to natural gas cost provide the best opportunities for stationary fuel cells.

Successful Commercialization Will Have Significant Impact on Employment *(% increase from base case)*



Cost of Incentives *(for vehicles and fueling stations)* Will Average Less than $3 billion/year over 15 years*



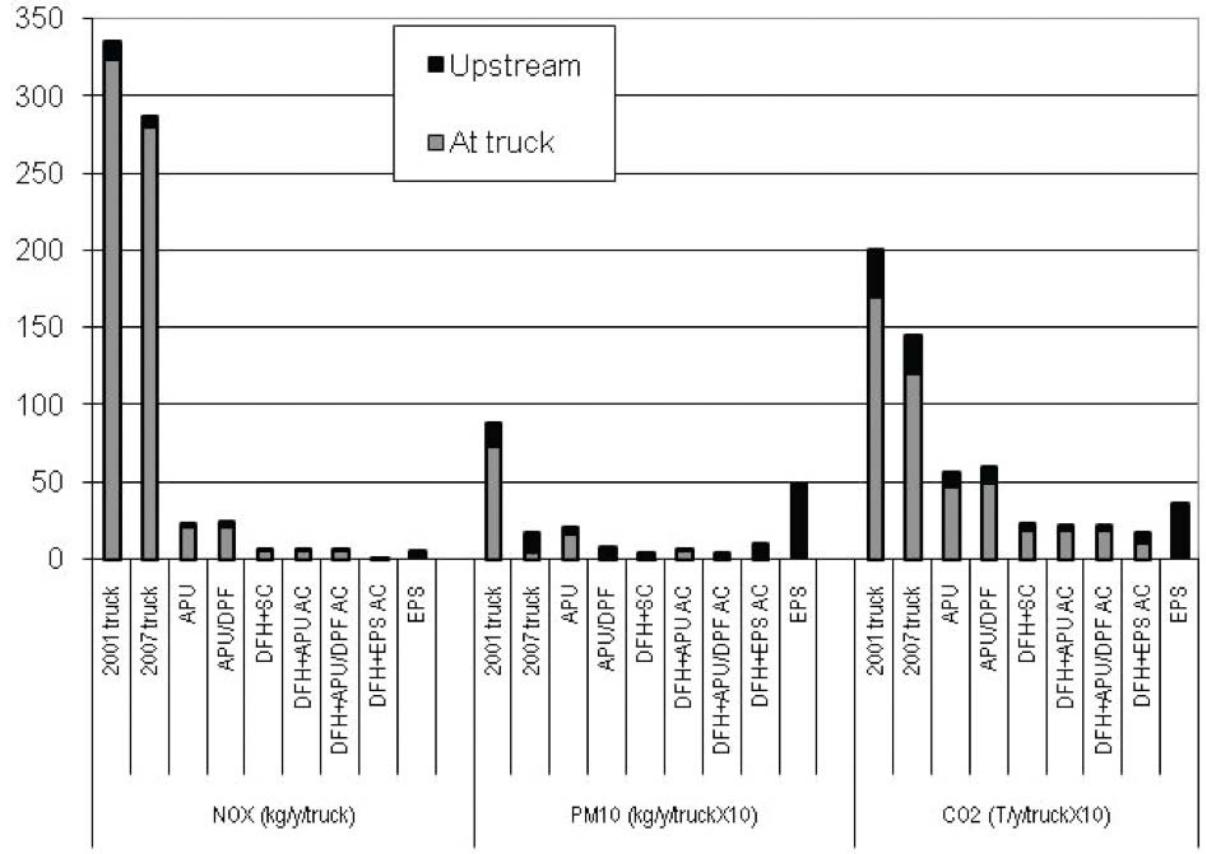
**** This is substantially lower than the cost of alternative fuel incentives already in place.***

Auxiliary Power Units (APUs) & Portable Power

Potential Oil Savings and Emissions Reductions from fuel cell APUs:

> 60 million gallons of diesel in 2030 and 160 million gallons in 2050

> 0.7 MT CO_2 per year in 2030 and 1.9 million MT CO_2 per year in 2050



Portable Power Benefits

- Extended run-time for consumer electronics — through improved energy density
- Improved mobility through portable rechargers
- Fast refueling
- Weight savings over batteries

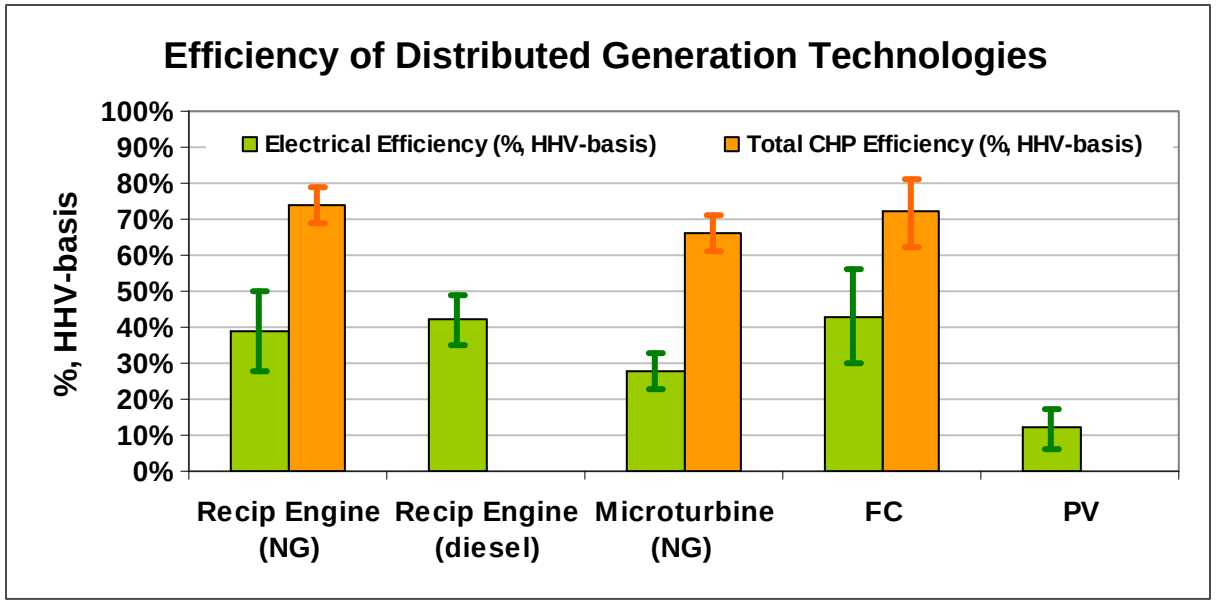
Emissions from diesel-powered fuel cell APUs would be comparable to the "upstream" emissions for APUs in this chart.

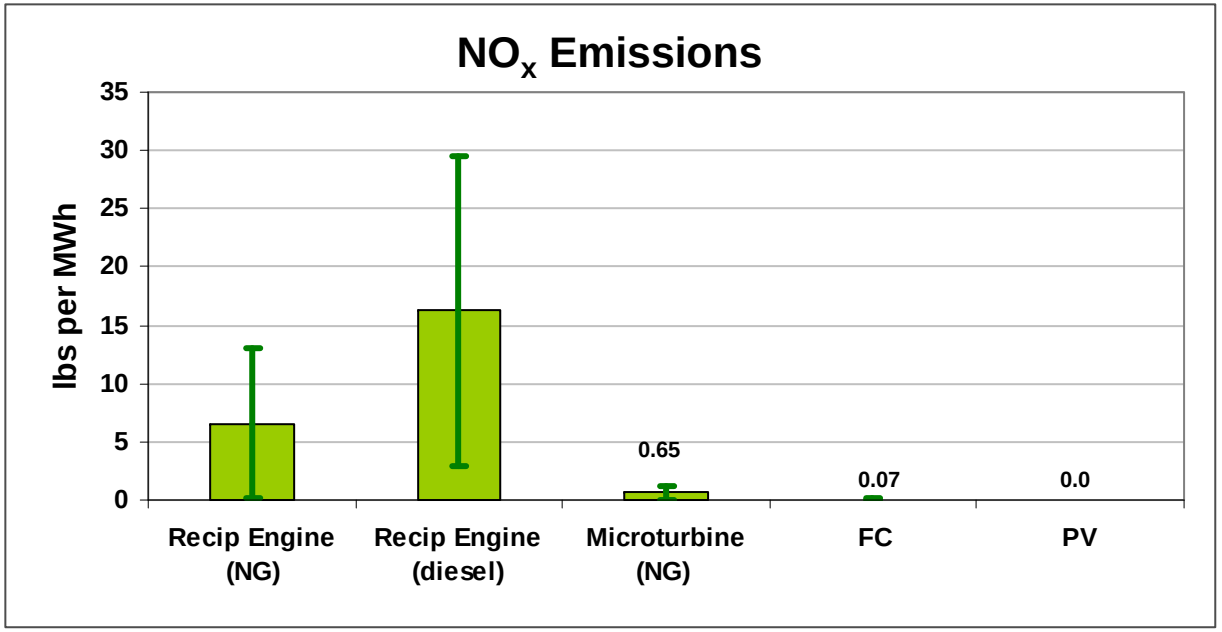
Fuel Cell APU would be better than conventional APU (NOX, PM10 and CO2).

DPF: Diesel particulate filter EPS: Electrified parking space

DFH: Direct-fired heater SC: Stored cooling AC (thermal storage)

Benefits of Fuel Cells — *for Distributed Power & Heat*





Sources: NREL, EPA, EPRI, and E Source Companies, LLC

Market Transformation

Potential deployments at DOE facilities: We are investigating the possibility of using fuel cells for primary power where high electricity costs and RPS constraints exist.